REFERENCE 15

ANL-W Pond 779 Seepage Test
D.R. Braun, November 1992

Report No. EGG-FE-10499
Project File No. 015578

ANL-W 779 POND SEEPAGE TEST

D. R. Braun

November 1992

Idaho National Engineering Laboratory
EG&G Idaho, Inc.
Idaho Falls, Idaho 83415

Prepared for the
U.S. Department of Energy
Office of Environmental Restoration and Waste Management
Under DOE Idaho Field Office
Contract DE-AC07-761D01570

ABSTRACT

A seepage test was performed for two Argonne National Laboratory - West (ANL-W) sanitary wastewater treatment ponds, Facility 779. The test period was August 28 to September 14, 1992. The southwest pond seepage rate is estimated to be 0.20 inch per day based upon the field data collected between August 31 and September 10, 1992. The north pond seepage rate is estimated to be 0.02 inch per day based upon the field data collected between August 31 and September 14, 1992.

ACRONYMS

ANL-W	Argonne National Laboratory - West
INEL	Idaho National Engineering Laboratory
NOAA	National Oceanic & Atmospheric Administration
PTI	Protection Technology Idaho

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SEEPAGE TEST

INTRODUCTION

The ANL-W 779 sanitary wastewater treatment ponds are located on the Idaho National Engineering Laboratory (INEL), north of the Argonne National Laboratory - West (ANL-W) site. Seepage rates were measured to determine if the ponds are a wastewater land application facility. The common industry standard for wastewater land application facilities is a field-measured seepage rate of one quarter inch per day or greater.

The southwest pond receives ANL-W wastewater and has gently sloping sides covered with rounded cobbles and a bentonite liner bottom (ANL-W Letter of October 12, 1992). This is a small pond and the wastewater surface area was approximately 0.6 acres during the test period.

The north pond receives wastewater from the southwest pond under normal operating conditions. The north pond has synthetically lined sides covered with rounded cobbles and a bentonite liner bottom (ANL-W Letter of October 12, 1992). This larger pond had a wastewater surface area of approximately 1.5 acres during the test period.

The two tested ponds have been in use for several years. A third pond was not tested, has not been in use since 1983, and is now used for emergency overflow only (ANL-W Letter of October 12, 1992). Drawing IPE-75C-1 shows the location and configuration of the ponds.

PROCEDURE

The test procedure was based upon the guidelines provided by the Idaho Division of Environmental Quality. The guidelines for evaluating seepage rates are presented in Appendix A. The seepage test deviated from the guidelines in the following areas.

The stilling well for the southwest pond was located in the transfer structure and the stilling well for the north pond was located near the south end of the pond. The guidelines recommend locating stilling wells in the center of ponds.

The southwest pond received influent during the test period. The guidelines recommend blocking influent flows.

Multiple personnel were utilized to perform the test. The guidelines recommend that one individual be responsible for all measurements.

DATA COLLECTION

Data collection began August 28 and concluded September 14, 1992, for a total of 16 days. Water surface measurements were recorded each Monday, Wednesday, and Friday morning, with the exception of Labor Day week when measurements were taken on Tuesday and Thursday mornings. Pump operating times were reported by ANL-W personnel. Precipitation was recorded by EG&G Idaho, PTI, and ANL-W personnel. Air temperature was monitored continuously and reported by NOAA personnel.

INFLUENT

During the test period, production of wastewater could not be avoided and the wastewater could not be diverted. However, transfer of wastewater between the ponds was discontinued. The southwest pond received influent and had no effluent. The north pond had no influent or effluent.

The southwest pond received wastewater from ANL-W during the test period. Two pumps are used by the wastewater system. Pump meter readings were not recorded, but estimates of pump operating durations were provided. The discharge rate of each pump was reported to be 50 gallons per minute. The southwest pond influent was computed using the estimated operating time and the pump discharge rate.

EVAPORATION AND PRECIPITATION

The pond evaporation rate was estimated by correlation with a measured evaporation rate in a large pan. The Class A evaporation pan was located on a berm of the southwest pond and the water surface was measured using a hook gage. The change in water surface was the net pan evaporation rate. A rain gage was used to measure the precipitation. The rain gage was attached to a post of the fence surrounding the ponds. The air temperature was recorded and the mean air temperature was calculated. A coefficient was selected based upon mean air temperature. The coefficient was applied to the net pan evaporation, less the precipitation, and the net pond evaporation rate was estimated.

SEEPAGE

The water surface of the two ponds was measured using two stilling wells and a hook gage. The stilling well for the southwest pond was located inside the transfer structure between the southwest and the north ponds. The stilling well for the north pond was a stand-alone stilling well which was placed in the north pond near the south end. The change in each pond water surface was equated to the net flow, net evaporation, and seepage. The seepage rate for each pond was calculated by solving the equation. The calculations are presented in Appendix B.

CONCLUSION

The mean seepage rate for the southwest pond is based upon four tests conducted from August 31 to September 10, 1992. The mean seepage rate for the north pond is based upon five tests conducted from August 31 to September 14, 1992. The test period from August 28 to 31, 1992, was not utilized. A measurement error may have occurred that resulted in an unreasonable pan evaporation rate of 1.1 inch per day for the period. The test period from September 10 to 14, 1992, was not utilized for the southwest pond. Pump operating time estimates were not sufficient to estimate the influent for the period.

The mean seepage rate for the southwest pond is estimated to be 0.20 inch per day. The seepage rates have a standard deviation of 0.11 inch per day. The 95% confidence interval of the mean seepage rate has an upper limit of 0.37 inches per day and a lower limit of 0.03 inch per day.

The mean seepage rate for the north pond is estimated to be 0.02 inch per day. The seepage rates have a standard deviation of 0.09 inch per day. The 95% confidence interval of the mean seepage rate has an upper limit of 0.13 inch per day and a lower limit of -0.10 inch per day.

The calculations are presented in Appendix B which contains an Engineering Design File (EDF) prepared to document this test. The EDF contains a graph of the test results, mean seepage rate, and confidence interval for each pond. The mean field-tested seepage rate of each pond is less than the industry standard wastewater land application rate.

APPENDIX A

IDAHO DIVISION OF ENVIRONMENTAL QUALITY

GUIDELINES FOR EVALUATING SEEPAGE RATES

IDAHO DEPARTMENT
OF HEALTH AND WELFARE

DIVISION OF
ENVIRONMENTAL QUALITY

Post Office Box 1626, Twin Falls, ID 83303-1626, (208) 734-9520

Cecil D. Andrus, Governor Richard P. Donovan, Director

September 4, 1991

WATER QUALITY PROGRAM GUIDANCE
No. MFC-8

SUBJECT

Procedure for evaluating wastewater treatment lagoon seepage rates.

PURPOSE

To establish a uniform standard procedure by which new and existing wastewater treatment lagoons can be evaluated to determine status of compliance with State seepage rate requirements.

DISCUSSION

Wastewater treatment lagoons constructed in the State of Idaho are required to meet a site-specific seepage rate as prescribed by the Department of Health and Welfare, Division of Environmental Quality. In the past, measurements to determine compliance with the required seepage rate have been performed utilizing a wide variety of instruments and procedures. Adoption of a standard testing procedure will ensure consistent seepage measurement techniques.

POLICY

1. Division of Environmental Quality staff will provide seepage rate allowances to the entity proposing to construct wastewater treatment lagoons.

2. All wastewater treatment lagoon plans and specifications submitted to the Division of Environmental Quality for review and approval must contain the following standard procedure.

3. Seepage test data must be submitted for review and approval.

_____
Originator

_____
Manager, Municipal Facilities Construction

_____
Chief, Water Quality Bureau

SEEPAGE TESTING PROCEDURE

Lagoons to be tested should be filled and maintained at design operational depth for at least two weeks prior to the beginning of the test period to allow for initial saturation (saturation period not required for synthetic lined lagoons). Measurements are to be taken at least every three (3) days over a period of fifteen (15) days (0,3,6,9,12,15) or until a consistent pattern is evident. One individual is to be responsible for all measurements and the measurements should be taken at the same hour of each test day.

Equipment

1. Precipitation gauge
2. Temperature recorder
3. Class A evaporation pan and stilling well
4. Hook gauge with Vernier scale accurate to 0.001 ft.
5. Appropriate length of 6 inch PVC pipe (Class 150 for stability) with suitable anchor support base for use as lagoon stilling well
6. Platform with support or boat for access to lagoon stilling well
7. Any necessary flow monitoring equipment.

Evaporation/Precipitation

A precipitation gauge is to be set up and monitored daily. The evaporation pan should be located on a level area as close to the lagoon as possible. If necessary, shims should be used to level the pan. The obvious concern is to try to duplicate lagoon exposure as nearly as possible (sun, wind, rain, etc.). The stilling well should be anchored in the pan with a rock or two and not moved once the test period begins. Initial water level in the pan should be about two (2) inches below the lip. Air temperature is continuously monitored to obtain the mean air temperature during the test period. The pan evaporation is multiplied by the pan coefficient (Table 1) to obtain the lagoon evaporation.

Lagoon Seal

The lagoon stilling well should be installed as near to the center of the cell as possible. The stilling well must be installed at 90 degrees to the water surface for accurate measurements. Access to the stilling well is by boat or by installing a temporary platform. (DO NOT impinge upon the stilling well). Mark a spot on the top of the stilling well to be used as a position indicator for the hook gauge. All measurements must be taken with the hook gauge in the same position.

Hook gauge readings shall be repeated a minimum of seven (7) times and numerically averaged.

Influent/effluent flows should be blocked to avoid unnecessary complications due to flow measurement errors.

General Notes

1. A water source will be necessary for both the lagoon and the evaporation pan.

2. When constructing new lagoons, it may be more practical to install a permanent stilling well before filling the lagoon rather than to use a temporary set-up.

3. A construction level will help in setting up the equipment properly.

4. On cloudy days, a flashlight may be helpful in seeing the hook gauge inside the stilling well.

Definitions

S_r is the seepage rate in inches per day.

S_2 is the seepage rate in gallons per acre per day.

E_{s1} is the pond surface elevation, day 1 in inches.

E_{sn} is the pond surface elevation, day n in inches.

ES is the pond surface elevation change in inches ($E_{s1} - E_{sn}$). Positive if the n day surface is lower than day 1; negative if the n day surface is higher than day 1.

I is the net pond evaporation which equals the net corrected pan evaporation in inches (may be a positive or negative number).

Q is the net effluent flow. May be positive (effluent > than influent flow) or negative (effluent < than influent flow). Value is zero if influent and effluent flows are blocked.

n is time in days.

P is pan coefficient from Table 1.

E_{pan1} is the evaporation pan surface, day 1 in inches

$E_{pan\ n}$ is the evaporation pan surface, day n in inches.

Calculations

Equation 1: $S_r = \frac{ES - I - Q}{n}$

Equation 2: $S_2 = S_r \frac{(in)(ft)(\text{lagoon surface area } ft^2)(7.48 \text{ gals.})}{(day)(12 \text{ in})(ft^3)}$
Lagoon surface area in acres

Equation 3: $ES = E_{sl} - E_{sn}$

Equation 4: $I = P[\text{precipitation} + E_{panl} - E_{pann}] - \text{precipitation}$

Equation 5: $Q = \frac{(\text{eff. flow} - \text{influent flow in gals.})(ft^3)(12in)}{(\text{lagoon surface area } ft^2)(7.48 \text{ gals.})(ft.)}$

Table 1

PAN COEFFICIENT

MEAN TEMP. °F	COEFFICIENT
30	1.2
35	0.953
40	0.907
45	0.860
50	0.814
55	0.767
60	0.721
65	0.674
70	0.628
75	0.581
80	0.536
85	0.488

Pan Evaporation

$$I = P[\text{recipitation} + E_{pan\,1} - E_{pan\,n}] - \text{precipitation}$$

NOTE: Solving for I in the above equation assumes that the precipitation event was short duration. If a precipitation event during a seepage test is of extended duration P should be multiplied by the factor:

$$\frac{\text{n hours - precipitation hours}}{\text{n hours}}$$

SPECIFICATIONS INSERT

Lagoon Liner - Liner integrity of each individual cell shall be evaluated in the following manner:

a. Evaporation - Shall be measured utilizing a Class A evaporation pan and stilling well arrangement. Measurements accurate to 0.012 inch (0.001 foot) shall be taken six (6) times over a period of fifteen (15) days (day 0,3,6,12,15). The pan coefficient for comparison is dependent on the mean air temperature (°F) over the test period and shall be taken from Table 1.

b. Precipitation/Air Temperature - Precipitation shall be measured using a standard precipitation gauge accurate to the nearest 0.01 inch. Measurements shall be recorded following each precipitation event. Air temperature (°F) shall be continuously monitored and recorded.

c. Lagoon - New Cells - Shall be filled and maintained at design operating level for at least two weeks prior to testing (not required for synthetic liners). During the test period, influent/effluent flows shall be blocked. A level, fixed stilling well located as near to the center of the lagoon as possible shall be used at the point for measurement. Measurements accurate to 0.012 inch (0.001 foot) shall be taken six (6) times over a period of fifteen (15) days (day 0,3,6,9,12,15).

Lagoon - Existing Cells - Influent/effluent flows shall be blocked and the above procedure followed.

Definitions

S_r is the seepage rate in inches per day.

S_2 is the seepage rate in gallons per acre per day.

E_{s1} is the pond surface elevation, day 1 in inches.

E_{sn} is the pond surface elevation, day n in inches.

ES is the pond surface elevation change in inches ($E_{s1} - E_{sn}$). Positive if the n day surface is lower than day 1; negative if the n day surface is higher than day 1.

I is the net pond evaporation which equals the net corrected pan evaporation in inches (may be a positive or negative number).

Q is the net effluent flow. May be positive (effluent > than influent flow) or negative (effluent < than influent flow). Value is zero if influent and effluent flows are blocked.

n is time in days.

P is pan coefficient from Table 1.

E_{pan1} is the evaporation pan surface, day 1 in inches

$E_{pan\ n}$ is the evaporation pan surface, day n in inches.

Calculations

Equation 1: $S_r = \frac{ES - I - Q}{n}$

Equation 2: $S_2 = S_r \frac{(in)(ft)(\text{lagoon surface area } ft^2)(7.48 \text{ gals.})}{(day)(12 \text{ in})(ft^3)}$

Lagoon surface area in acres

Equation 3: $ES = E_{s1} - E_{sn}$

Equation 4: $I = P[\text{precipitation} + E_{pan1} - E_{pann}] - \text{precipitation}$

Equation 5: $Q = \frac{(\text{eff. flow} - \text{influent flow in gals.})(ft^3)(12in)}{(\text{lagoon surface area } ft^2)(7.48 \text{ gals.})(ft.)}$

APPENDIX B

ANL-W 779 SEEPAGE CALCULATIONS

(EDF ANL779-DRB-01)

EG&G Idaho, Inc
FORM EG&G-2631 (Rev. 12-88)

Project File Number 015578

EDF Serial Number ANL779-DRB-01

Functional File Number

ENGINEERING DESIGN FILE

Project/Task ANL-W 779 POND SEEPAGE TEST

Subtask ESTIMATE POND SEEPAGE RATE

EDF Page 1 of 1

Subject: PROCESS FIELD TEST DATA

Abstract:

The following calculations pertain to the seepage rate of the ANL-W 779 wastewater ponds. A field test began August 28 and concluded September 14, 1992. The estimated seepage rate for the southwest pond is 0.20 inch per day and based upon field data collected between August 31 and September 10, 1992. The estimated seepage rate for the north pond is 0.02 inch per day based upon field data collected between August 31 and September 14, 1992.

References:

Idaho Division of Environmental Quality Guidelines for Evaluating Seepage Rates.

Probability and Statistics for Engineering and the Sciences, Jay L. Devore, 1982, Brooks/Cole Publishing Company.

Attachments:

Field Data Sheets
Temperture Record Sheet
Memo of Conversation - Pump Record Sheet
Seepage Calculations Speadsheet
Seepage Sample Calculations
Statistical Analysis and Graph
Drawing IPE-75C-1

Author DoANNA R. BRAUN Dept. E540

PROFESSIONAL ENGINEER REGISTERED 6580 11-13-92 STATE OF IDAHO DoANNA R. BRAUN

Distribution (complete package): D. R. Braun, C. J. Martin, Project File No. 015578

Distribution (cover sheet only): N. K. Rogers, S. L. Austad

Reviewed Date 11/16/92

Approved Date 11/16/92

POND SEEPAGE FIELD DATA

ARGONNE NATIONAL LABORATORY - WEST

IDAHO NATIONAL ENGINEERING LABORATORY

Project File No. 015578
Field Engineer: H. W. Clifford, EG&G Idaho, E220
Civil Engineer: D. R. Braun, EG&G Idaho, E540

PAN

Day/Date	Time a.m.	First Reading (feet)	Last Reading (feet)
00/F/ 8/28/92		XXX	2.21
03/M/ 8/31/92			1.924
05/W/ 9/02/92			1.880
07/F/ 9/04/92			1.863
11/T/ 9/08/92			1.808
13/T/ 9/10/92			1.760
16/M/ 9/14/92			XXX 1.668

POND SEEPAGE FIELD DATA

ARGONNE NATIONAL LABORATORY - WEST

IDAHO NATIONAL ENGINEERING LABORATORY

Structure: Southwest Sanitary Wastewater Treatment Pond
Project File No. 015578
Field Engineer: H. W. Clifford, EG&G Idaho, E220
Civil Engineer: D. R. Braun, EG&G Idaho, E540

SOUTHWEST POND

Day/Date	Readings, (feet) 1	2	3	4	5	6	7
00/ 8/28	0.093	0.091	0.091	0.092	0.093	0.092	0.093
03/ 8/31	0.236	0.237	0.239	0.237	0.237	0.236	0.238
05/ 9/02	0.317	0.317	0.318	0.319	0.318	0.316	0.317
07/ 9/04	0.438	0.442	0.436	0.438	0.436	0.438	0.436
11/ 9/08	0.455	0.458	0456	0.456	0.458	0.458	0.456
13/ 9/10	0.576	0.560	0.562	0.562	0564	0.562	0.564
16/ 9/14	0.774	0.785	0.778	0.776	0.778	0.776	0.778

POND SEEPAGE FIELD DATA

ARGONNE NATIONAL LABORATORY - WEST

IDAHO NATIONAL ENGINEERING LABORATORY

Structure: North Sanitary Wastewater Treatment Pond
Project File No. 015578
Field Engineer: H. W. Clifford, EG&G Idaho, E220
Civil Engineer: D. R. Braun, EG&G Idaho, E540

NORTH POND

Day/Date	Readings, (feet) 1	2	3	4	5	6	7
00/ 8/28	1.398	1.397	1.398	1.397	1.398	1.399	1.398
03/ 8/31	1.358	1.358	1.356	1.356	1.358	1.359	1.357
05/ 9/02	1.352	1.352	1.354	1.353	1.354	1.351	1.351
07/ 9/04	1.332	1.330	1.332	1.332	1.332	1.330	1.332
11/ 9/08	1.283	1.287	1.286	1.284	1.284	1.286	1.284
13/ 9/10	1.226	1.226	1.228	1.226	1.228	1.228	1.226
16/ 9/14	1.165	1.166	1.168	1.166	1.168	1.165	1.166

POND SEEPAGE DATA

ARGONNE NATIONAL LABORATORY - WEST

IDAHO NATIONAL ENGINEERING LABORATORY

Project File No. 015574
Field Engineer: H. W. Clifford, EG&G Idaho, E220
Civil Engineer: D. R. Braun, EG&G Idaho, E540

PRECIPITATION GAGE

Day/Date	Reading (inches)	Day/Date	Reading (inches)	Day/Date	Reading (inches)
00/ 8/28	xxx	07/ 9/4	0.10	14/ 9/11	
01/ 8/29		08/ 9/5	0.10	15/ 9/12	0
02/ 8/30		09/ 9/6	0.20	16/ 9/13	0
03/ 8/31	0	10/ 9/7	0.20	17/ 9/14	0
04/ 9/1	0.22	11/ 9/8	0		
05/ 9/2	0.25	12/ 9/9			
06/ 9/3	0	13/ 9/10	0		

Daily Mean Temperatures for EBR2 (10m level)

Prepared by Neil Hukari (Phone: 526-2744, INEL Mail Stop 2600)

U. S. Department of Commerce
National Oceanic and Atmospheric Administration
Environmental Research Laboratories
Air Resources Laboratory
Field Research Division
1750 Foote Drive
Idaho Falls, ID 83402

Date	10m level EBR2 mean temperature (deg F.)	Number observations (pcnt available)	Notes
28 Aug 1992	68.5	240 (100.0)	
29 Aug 1992	63.8	240 (100.0)	
30 Aug 1992	64.4	240 (100.0)	
31 Aug 1992	56.9	240 (100.0)	
1 Sep 1992	55.7	240 (100.0)	
2 Sep 1992	62.0	240 (100.0)	3 estimated observations
3 Sep 1992	62.0	240 (100.0)	2 estimated observations
4 Sep 1992	54.9	240 (100.0)	7 estimated observations
5 Sep 1992	52.0	240 (100.0)	5 estimated observations
6 Sep 1992	50.4	240 (100.0)	3 estimated observations
7 Sep 1992	46.4	240 (100.0)	39 estimated observations
8 Sep 1992	57.3	240 (100.0)	2 estimated observations
9 Sep 1992	56.6	240 (100.0)	9 estimated observations
10 Sep 1992	59.5	240 (100.0)	8 estimated observations
11 Sep 1992	(64.8)	240 (100.0)	CFA Data; EBR2 unavailable
12 Sep 1992	(57.6)	240 (100.0)	CFA Data; EBR2 unavailable
13 Sep 1992	(48.9)	240 (100.0)	CFA Data; EBR2 unavailable

Averages are based on data set of temperature averages taken at six minute intervals.

EG&G Idaho, Inc.

FORM EG&G-0561
(Rev. 05-88)

MEMO OF CONVERSATION

PERSON CALLING: DeAnna R. Braun DATE: September 1992

REPRESENTING ORG: EG&G Idaho TIME: ____ AM: __ PM: __

PERSON CALLED: Chris J. Martin PHONE NUMBER: 533-7621

REPRESENTING CO: ANL-W

SUBJECT: ANL-W 779 POND SEEPAGE TEST - Pond Influent

Initially one pump meter was recorded. When the influent quantities were considered too low, another pump meter was identified. The following are estimates of the pumping durations. The discharge rate of the pumps is 50 gallons per minute.

DATE	PUMP (minutes)
8/28	603.4
8/29	307.6
9/1	302.8
9/2	302.8
9/3	307.6
9/4	583.9
9/8	284.0
9/9	1338.8
9/14	231.4

An additonal 6000 gallons to 8000 gallons was discharged on approximately 9/11.

DISTRIBUTION a: Project File No. 015578

SIGNATURE: D R Braun

POND SEEPAGE TEST (ANL-W 779)

SEEPAGE CALCULATIONS SPREADSHEET
(Lotus 1-2-3 v 2.01)

Project File No. 015578
EDF ANL779-DRB-01

DATE	PAN CHANGE (inch)	PRECIP (inch)	PAN TEMP COEF	NET POND EVAP (inch)	SW POND INFLUENT (gal)	SW POND NET FLOW (inch)	SW POND CHANGE (inch)	TIME (day)	SW POND SEEPAGE (inch/day)	N POND CHANGE (inch)	N POND SEEPAGE (inch/day)
AUG 28											
AUG 31	3.432	0	0.674	2.313	30170	-1.844	-1.740	3	-0.736	0.492	-0.607
SEPT 2	0.528	0.45	0.767	0.300	30520	-1.866	-0.960	2	0.303	0.060	-0.120
SEPT 4	0.204	0.1	0.721	0.119	30520	-1.866	-1.452	2	0.147	0.252	0.066
SEPT 8	0.660	0.5	0.814	0.444	29195	-1.785	-0.228	4	0.278	0.552	0.027
SEPT 10	0.576	0	0.767	0.442	30520	-1.866	-1.284	2	0.070	0.696	0.127
SEPT 14	1.104	0	0.721	0.796	XXXX	0.000	-2.568	4	-0.841	0.732	-0.016

NOTES

INFLUENT VALUES ARE ESTIMATES BASED UPON ESTIMATED PUMPING DURATIONS.

SIGN CONVENTION FOR WATER SURFACE: RISE = - DROP = +

THE PAN MEASUREMENT TAKEN ON AUGUST 28 MUST HAVE BEEN IN ERROR.
THE RESULTING PAN CHANGE, 1.1 INCH PER DAY, IS NOT REASONABLE FOR THE CLIMATE.
THIS MEASUREMENT INFLUENCES THE CALCULATED SEEPAGE RATE FOR BOTH PONDS.

INFORMATION PROVIDED FOR THE PERIOD SEPT 10 - 14 IS NOT SUFFICIENT FOR ESTIMATING SOUTHWEST POND INFLUENT. THIS INFORMATION INFLUENCES THE CALCULATED SEEPAGE RATE FOR THE SOUTHWEST POND ONLY.

FOR THE SOUTHWEST POND, THE RESULTS OBTAINED FOR AUG 31 - SEPT 10 WILL BE UTILIZED.

FOR THE NORTH POND, THE RESULTS OBTAINED FOR AUG 31 - SEPT 14 WILL BE UTILIZED.

POND SEEPAGE TEST (ANL-W 779)

Project File No. 015578, EDF ANL779-DRB-01

SEEPAGE SAMPLE CALCULATIONS

Hand Calculations for Verification of Spreadsheet Calculations

For Test Period September 2 - 4, 1992

PAN CHANGE

From Field Data Sheet, 1.880 - 1.863 = 0.017 ft * 12inch/ft = 0.204 inch

PRECIP

From Precipitation Record Sheet, 0.1 inch

PAN TEMP COEFF

Calculate Average Temperature for Test Period, From Temperature Record Sheet, Round to Nearest 5 degree Increment, 62 degrees

Identify Corresponding Temperature Coefficient, From Idaho Guidelines for Evaluating Seepage Rates, 0.721

NET POND EVAP

Net Pond Evap = Temp Coeff(Precip + Pan Change) - Precip
= 0.721(0.1 + 0.204) - 0.1 = 0.119 inch

SOUTHWEST POND INFLUENT

From ANL-W 610.4 minutes * 50 gallons per minute = 30,520 gallons

SOUTHWEST POND NET FLOW

Pond Surface Area = 162 x 162 = 26,244 sq.ft.

Net Flow = influent/pond surface area
= (-30520 gal)(1 cu.ft./7.48 gal)(12 in/ft)/26,244 sq.ft.
= -1.866 inch

POND CHANGE

SOUTHWEST POND
From Field Data Sheet
Average of 9/02 = 0.317 ft
Average of 9/04 = 0.438 ft
Pond Change = 0.317 - 0.438 = -0.121 ft * 12 inch/ft = -1.452 inch

NORTH POND
From Field Data Sheet
Average of 9/02 = 1.352 ft
Average of 9/04 = 1.331 ft
Pond Change = 1.352 - 1.331 = 0.021 ft * 12 inch/ft = 0.252 inch

POND SEEPAGE TEST (ANL-W 779)

Project File No. 015578, EDF ANL779-DRB-01

SEEPAGE SAMPLE CALCULATIONS

TIME

Sept 2, 8:00 a.m. to Sept 4, 8:00 a.m. = 2 days

SEEPAGE RATE

SOUTHWEST POND
Pond Change = Seepage + Net Evap + Net Flow
-1.452 = Seepage + 0.119 - 1.866
Seepage = 0.295 inch

Seepage Rate = Seepage/Time
= 0.295/2 = 0.147 inch per day

NORTH POND
Pond Change = Seepage + Net Evap + Net Flow
0.252 = Seepage + 0.119 - 0
Seepage = 0.133 inch

Seepage Rate = Seepage/Time
= 0.133/2 = 0.066 inch per day

SIGN CONVENTION

Water Surface Drop = +

Water Surface Rise = -

POND SEEPAGE TEST (ANL-W 779)

Project File No. 015578, EDF ANL779-DRB-01

STATISTICAL ANALYSIS

Assumptions: The actual pond seepage rates are nearly constant for the test period. The actual pond seepage rates are greater than zero based upon the low water table in the vicinity of the ponds. The fluctuation of the test results is due to measurement error. The tests will be treated as separate, not one long test.

SOUTHWEST POND

Only the period August 31 - September 10, 1992 will be utilized.

MEAN SEEPAGE RATE

Number of Tests = n = 4

Sample Mean = x = summation of seepage rates / n

Southwest Pond Mean = (0.303 + 0.147 + 0.278 + 0.070) / 4 = 0.200 inch/day

STANDARD DEVIATION

Sample Standard Deviation = s = positive square root of sample variance

Sample Variance = (summation of (test results - sample mean)^2) / n - 1

Southwest Pond Standard Deviation = (((0.303 - 0.200)^2 + (0.147 - 0.200)^2 + (0.278 - 0.200)^2 + (0.070 - 0.200)^2) / (4 - 1))^ 1/2 = 0.110 inch/day

CONFIDENCE INTERVAL OF THE MEAN

Assumptions: The number of tests is small (less than 30). The test results represent a random sample from a normal population.

Confidence Level = 95 % (alpha = 0.05, alpha/2 = 0.025)

Number of Degrees of Freedom = n - 1 = 4 - 1 = 3

t = 3.18 (t distribution table)

Upper Limit of Confidence Interval = x + ts/n^1/2

Lower Limit of Confidence Interval = x - ts/n^1/2

Upper Limit of Southwest Pond = 0.200 + 3.18*0.110/4^1/2 = 0.37 inch/day

Lower Limit of Southwest Pond = 0.200 - 3.18*0.110/4^1/2 = 0.03 inch/day

POND SEEPAGE TEST (ANL-W 779)

Project File No. 015578, EDF ANL779-DRB-01

STATISTICAL ANALYSIS

NORTH POND

Only the period August 31 - September 14, 1992 will be utilized.

MEAN SEEPAGE RATE

Number of Tests = n = 5

Sample Mean = x = summation of seepage rates / n

North Pond Mean = (-0.120 + 0.066 + 0.027 + 0.127 + -0.016) / 5 = 0.017 inch/day

STANDARD DEVIATION

Sample Standard Deviation = s = positive square root of sample variance

Sample Variance = (summation of (test results - sample mean)^2) / n - 1

North Pond Standard Deviation = (((-0.120 - 0.017)^2 + (0.066 - 0.017)^2 + (0.027 - 0.017)^2 + (0.127 - 0.017)^2 + (-0.016 - 0.017)^2) / (5 - 1))^1/2 = 0.093 inch/day

CONFIDENCE INTERVAL OF THE MEAN

Assumptions: The number of tests is small (less than 30). The test results represent a random sample from a normal population.

Confidence Level = 95 % (alpha = 0.05, alpha/2 = 0.025)

Number of Degrees of Freedom = n - 1 = 5 - 1 = 4

t = 2.78 (t distribution table)

Upper Limit of Confidence Interval = x + ts/n^1/2

Lower Limit of Confidence Interval = x - ts/n^1/2

Upper Limit of North Pond = 0.017 + 2.78*0.093/5^1/2 = 0.13 inch/day

Lower Limit of North Pond = 0.017 - 2.78*0.093/5^1/2 = -0.10 inch/day

EG&G Idaho, Inc.

FORM EG&G-2631A (Rev 4-78)

PROJECT FILE NO 015578

EDF SERIAL NO ANL 779-DRB-01

FUNCTIONAL FILE NO

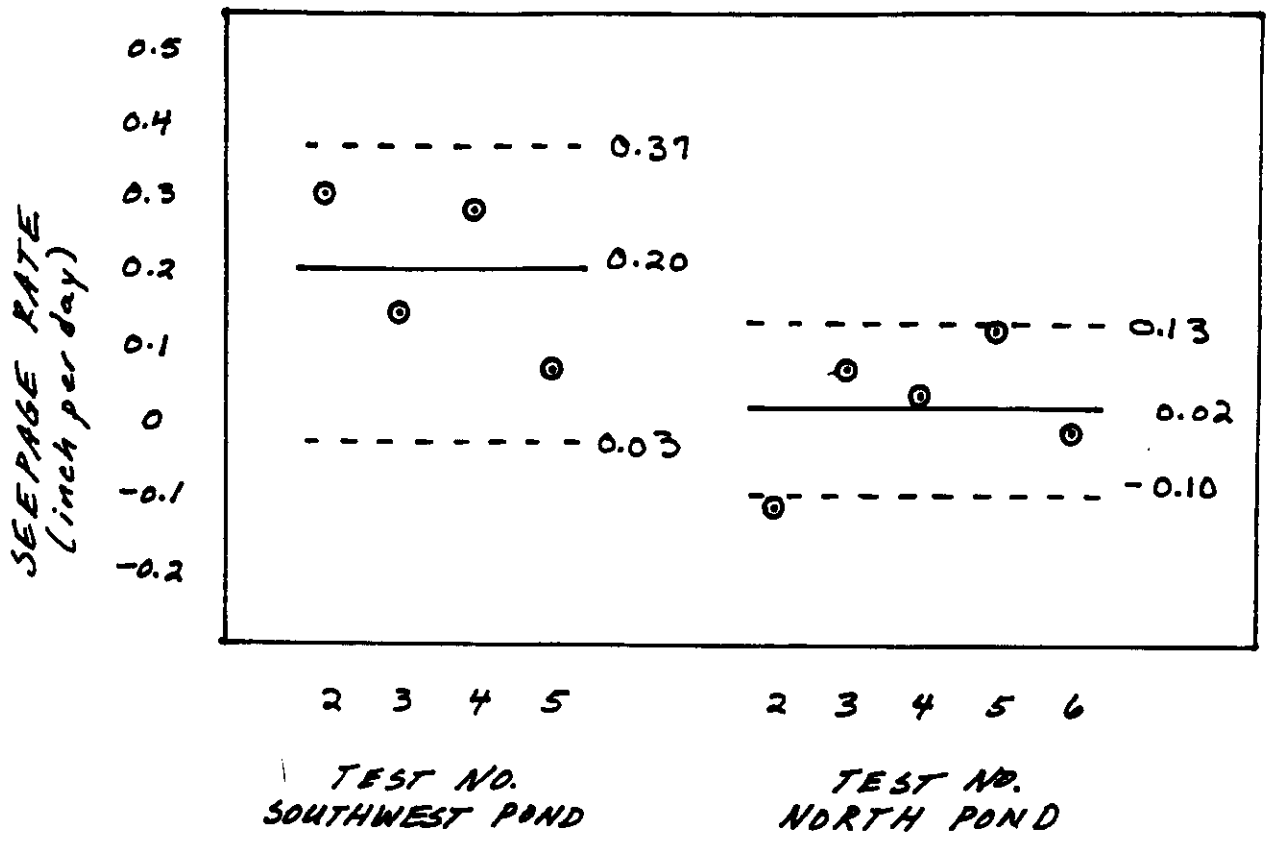
DATE MAY 92

ENGINEERING DESIGN FILE

PROJECT/TASK ANL-W 779 POND SEEPAGE TEST

SUBTASK ESTIMATE POND SEEPAGE RATE

ABSTRACT

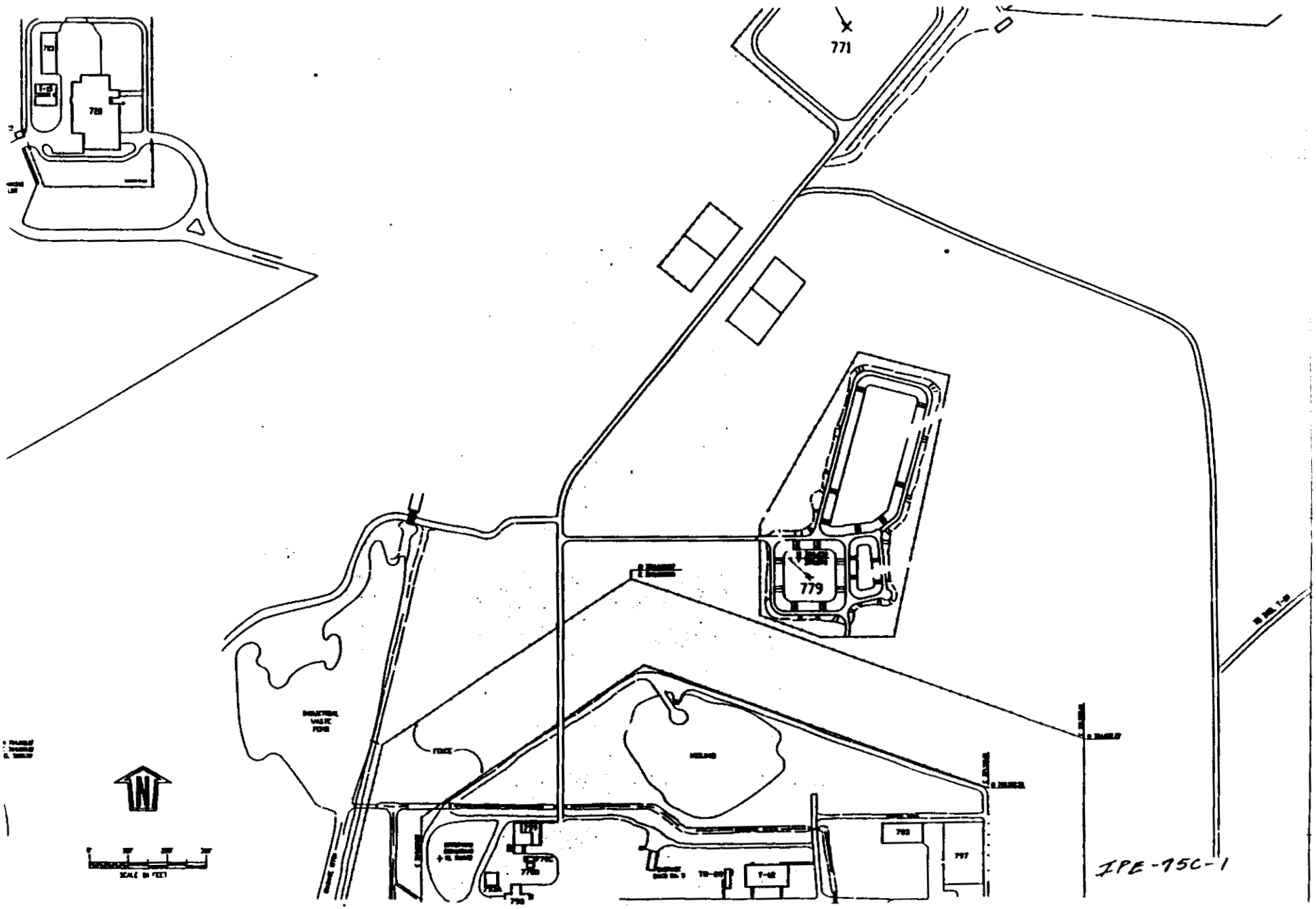


LEGEND

⊙ TEST RESULT

— MEAN

-- 95% CONFIDENCE LIMIT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